STATE OF CALIFORNIA AIR RESOURCES BOARD

MONITORING AND LABORATORY DIVISION

QUALITY ASSURANCE SECTION

VOLUME V

AUDIT PROCEDURES MANUAL

FOR

AIR QUALITY MONITORING

APPENDIX E

PERFORMANCE AUDIT PROCEDURES

FOR

THROUGH-THE-PROBE CRITERIA AUDITS

MARCH 2002

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E.1.0 INTRODUCTION

E.1.0.1 GENERAL INFORMATION

California Air Resources Board's Air Quality Monitoring Procedure addresses requirements for the set-up and operation of audit equipment used to conduct performance audits as specified in 40 CFR 58, Appendix A. Read the entire procedure before beginning the audit.

The Quality Assurance Section (QAS) conducts through-the-probe audits by diluting known quantities of National Institute of Standards and Technology (NIST) traceable gases with 16 liters per minute (lpm) of pure air to achieve concentrations of pollutants at the ambient levels. These ambient level gas mixtures also serve to test the integrity of the entire sampling system. This is accomplished by introducing the diluted gas mixture into the probe inlet, where it is drawn through the sampling system by the air monitoring analyzers.

An Environics 9100 gas calibrator (calibrator) is used to control the dilution of high concentration gases from compressed gas cylinders containing CO, NO, SO2 and CH4; CO and H2S; CO and C3H8. The calibrator is also equipped with an ozone generator for conducting ozone audits. An API 400a ambient level ozone analyzer is used to determine true ozone concentrations. A TECO 48c CO analyzer (TECO 48c) is calibrated at two know ambient level concentrations (7 ppm and 40 ppm) and at zero, using API 701 zero air and Ultrapure zero air. After calibration, the TECO 48c is used to trace the level of CO present in diluted gas samples. The TECO 48c response to the level of CO present in the diluted gas samples is used for auditing CO analyzers and to determine the true concentrations of all other gases present in multiblend cylinders.

The gases and transfer standards used in performance audits are certified semi-annually by the in-house Standards Laboratory of the Program Evaluation and Standards Section.

E.1.0.2 EQUIPMENT

The current through-the-probe audit system uses the following equipment:

1. Audit van with 240 VAC landline and 15.0 kW AC Generator.

2. Elgar 1001SL-II voltage stabilized line conditioner, with a 402SD-001 selectable frequency oscillator or Powerware 9125 Uninterruptible Power Source.

3. Compressed gas cylinders traceable to NIST.

    a. Carbon Monoxide, 38-42 ppm (High CO), and 6-8 ppm (Low CO).

    b. Ultrapure zero air.

    c. Superblend 1: Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitric Oxide (NO), and Methane (CH4).

    d. Superblend 2: Carbon Monoxide (CO), and Hydrogen Sulfide (H2S).

    e. Superblend 3: Carbon Monoxide (CO) and Propane (C3H8).

4. API Model 701 zero air generator.

5. Environics 9100 Computerized Ambient Calibrator with an ozone generator.

6. API Model 400a Ozone analyzer.

7. TECO 48c Carbon Monoxide analyzer.

8. TECO 42c Nitric Oxide analyzer.

9. 150 feet of 7/16", inside diameter (I.D.), Teflon line with stainless steel over-braiding.

10. 1-10 lpm by-pass rotameter and glass mixing tees.

11. 0-30 lpm Mass Flow Meter.

12. Omega PX961 Electronic Barometer.

13. Six two-way and two three-way 24 VDC solenoid valves to actuate the zero air supply and gas cylinders.

14. Control panel with eight on-off switches, eight 1-amp 400 Peak Inverse Voltage clamping diodes and one 24 VDC rack mounted power supply.

15. Audit software that will gather, calculate, store audit data, and generate a report upon completion of the audit.

E.1.1 START-UP PROCEDURES

E.1.1.1 VAN EXTERIOR

1. Open the generator compartment door and verify that the oil is in the "Safe" operating range.

2. Remove the "Dust Cap" from the end of the 150' audit gas presentation line "Line".

E.1.1.2 VAN INTERIOR

1. Make certain that the generator/land line power source selector is in the neutral (unloaded) position (if so equipped).

2. Check to make certain that all circuit breakers are "ON".

3. Start the generator. After the generator speed is stable (5 minutes) place the power control switch in the generator (loaded) position if it is not equipped with an automatic switchover.

4. Turn "ON" the power to the Elgar or Powerware line voltage and frequency conditioner.

5. Turn "ON" the power to the API 701 zero air module.

6. Turn "ON" the power to the Omega PX961 Electronic Barometer.

7. Turn on the following instruments when conducting audits for:

   a. Ozone: Environics 9100 and API 401a.

   b. Ozone, CO, SO2, and CH4: Environics 9100, API 401a, and TECO 48c.

   c. Ozone, CO, SO2, CH4, and NO2: Environics 9100, API 401a, TECO 48c, and TECO 42c.

   d. H2S: Environics 9100 and TECO 48c.

   e. CH4: Environics 9100 and TECO 48c.

   g. NMHC – Environics 9100 and TECO 48c.

8. Turn "ON" the power to the Yokogawa Chart Recorder (chart recorder) and press "RECORD".

9. Allow a 1-hour warm-up time for the API 400a and a 3½-hour warm-up time for the TECO 48c and TECO 42c.

E.1.1.3 INITIAL SITE SET-UP

1. Attach a 2-foot section of ¼" OD Teflon tubing to the end of the "Line".

2. Verify that the API 701 and all instruments are operating properly.

3. Record the site name, site number, date of audit, and the auditors' names on the van chart and station chart (if so equipped).

4. Enter the beginning audit time, ending audit time, and the auditors' names, in the station logbook or computer.

5. Before attaching the "Line" to the station's inlet probe, record the value of the station magnehelic (used to measure manifold inlet pressure), if so equipped, on the QA Audit Station Data Worksheet (station worksheet, Figure E.1.2.1) as the "Before Audit Magnehelic Reading".

6. Determine the van's actual output flow at the end of the "Line" using a Mass Flow Meter (MFM) or Vol-o-flow. The output flow should be greater than 11 lpm. The site's inlet flow can be determined by totaling the flow of all instruments, in addition to any auxiliary pumps used to reduce residence time. Record both flows on the QA Audit Van Data Worksheet (van worksheet, Figure E.1.2.2).

   NOTE: The "Line" output flow must be at least 2 lpm greater than the station's inlet flow. If the "Line" output flow is not within this range, disable (or reduce the flow) to the auxiliary pump on the station's instrument manifold. If this is not done, dilution of the audit gases will occur.

7. If the "Line" output flow exceeds the station's inlet flow by more than 5 lpm, make certain that the excess flow is properly by-passed.

   EXAMPLE: A glass tee of equal interior diameter may be used as a by-pass by inserting the Teflon tubing attached to the "Line" into the side port. Secure the "Line" to the probe and attach the station's inlet probe to the top port and allow the excess flow to be vented out the bottom port (see E.1.1.5). On very windy days, attach an equal diameter Tygon tubing, at least 10" in length, to the open port of the glass tee to prevent ambient air from diluting the audit gases.

8. Check the van's front manifold by-pass flow. If the by-pass flow is not 0.3-0.4 lpm, adjust the flow using the needle valve for the by-pass rotameter.

E.1.1.4 VAN OZONE INSTRUMENT OPERATIONAL CHECK

1. After a 1-hour warm-up, review the test values on the front panel of the API 400a by pressing the leftmost keyboard function labeled "TEST". Check the following parameters:

   a. Ozone reference and Ozone measure: TEST function values should be between 4200 and 4700 mV.

   b. Pressure: Should be 29" to 30" Mercury-Absolute at sea level. Other values will be displayed at different altitudes.

   c. Sample Flow: Should be 800 cc/min (± 10%). However sample flow can be as low as 600 cc/min and still operate properly. Do not operate the API 400a at low flow for prolonged periods of time. If the sample flow is below 600 cc/min, it will be necessary to clean the orifice to bring the sample flow back into the proper range (see instrument manual).

   e. Sample Temperature: Ambient temperature (± 10^{o} C).

   f. Analytical Lamp Temperature: 52^{o} C. This value should remain stable.

   g. DC Power Supply: 2500 mV (± 50 mV). This value should be within the range indicated.

   h. Press "TEST" until the analyzer flow is displayed.

      NOTE: The inlet pressure to the calibrator must be maintained at 35 psi. Adjust the pressure regulator inside the API 701 if this pressure greater than ± 10% from target pressure (see instrument manual).

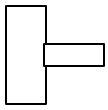
      NOTE: When adjusting the van's manifold pressure with the calibrator off, use the needle valve attached to the three-way solenoid near the rear manifold inlet.

E.1.1.5 FINAL SITE SET-UP

1. Connect the "Line" to the station's inlet probe, venting the excess flow to the atmosphere. The following are two suggestions to accomplish this.

   a. At all monitoring stations with ¼" to ½" outside diameter Teflon inlet probes, the top port of the glass tee should be connected to the probe inlet. Connect the ¼" Teflon tubing (attached to the "Line") to the side port of the tee. Allow the excess flow to vent out the bottom port.

      Top Port (attach to station inlet probe)

      Side Port (attach Teflon tubing from "Line")

      Bottom Port (vent excess flow)

   b. If the probe inlet is configured with a calibration port, disconnect the station's calibration line from the probe inlet and connect the "Line" to the calibration port using ¼" Teflon tubing.

2. After securing the "Line" to the station's inlet probe, recheck the station's manifold pressure (if so equipped). Record this value on the station worksheet in the space next to "During Audit".

3. Recheck the van by-pass flow. The by-pass flow should be 0.3 to 0.4 lpm as indicated by the by-pass rotameter. Readjust the flow using the needle valve if necessary.

E.1.2 THROUGH-THE-PROBE AUDIT

E.1.2.1 AUDIT VAN AND STATION DATA RETRIEVAL AND RECORDING

The station instrument responses for each pollutant are taken from the data acquisition system used for data-of-record. This data acquisition system may be a strip chart recorder, data logger, computer, or telemetry. The instrument responses are read or interpreted by the station operator (if present), and reported to the auditor. If the station operator is not present, the auditor reads or interprets the instrument responses based on data-of-record. The auditor records these responses on the station worksheet and enters them into the audit van computer for calculation of final results.

NOTE: The Van's Software program references calibration information (such as the ozone line loss factor, API 400a slope and intercept, and gas certification data) to calculate the van's true responses at each audit level. Record the van instrument display value on the van worksheet and into the van's software program. After the station data has been entered into the van software program for each audit level, percent differences are calculated.

The strip chart data retrieval is accomplished by taking pre- and post- zero station instrument responses (from the station chart recorder) in parts per million. The same process is used for instrument response at each audit level.

NOTE: The zero response is not used for calculating the final percent difference if the site operator/technician does not normally use zero correction when reducing the strip chart data.

With current technology, many monitoring stations are using electronic data loggers that store data at the site until collected on a set schedule. The data from the electronic data logger is handled in the same manner as the strip chart data, except that it is read directly from an electronic display at each audit level. The responses are recorded by the auditor on the station worksheet and entered into the audit van's software program.

Some remote stations use a telemetry system. The telemetry system is updated every few minutes on dedicated phone lines. The data are averaged and stored in a centrally located computer. The station instrument responses are generally obtained by the site operator/technician calling for the analyzer responses. In some monitoring stations this is accomplished by dialing the computer directly through a telephone modem. The response values are entered onto the station worksheet and into the audit van's software program.

E.1.2.2 OZONE AUDIT PROCEDURE

True Ozone (measured by the audit van's API 400a) is calculated by applying a slope and intercept (derived from the quarterly standards laboratory certification) to the API 400a's net display reading, and multiplying by the ozone line loss correction factor.

NOTE: True Ozone (ppm) = ((API 400a Display Response (ppm) – API 400a Zero Response (ppm) x API 400a Slope) + API 400a Ozone Intercept)) x API 400a Ozone Line Loss Correction Factor.

1. After a 1-hour warm-up, press the "CONC" mode button on the front panel of the Environics 9100 Calibrator (calibrator). Cursor to "TARGET FLOW" and enter "16.0" if it is not indicated. Cursor to "TARGET GAS" and enter "0.0" if it is not indicated. Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position to direct dilution air to the calibrator.

2. Audit Point 1: Press the "START" button on the front panel of the calibrator to deliver zero air to the van instruments and the air monitoring station (station). Adjust the flow to the by-pass rotameter until a 0.3-0.4 lpm by-pass is indicated. When the van and station readings are stable (10 minute stable strip chart trace), record the responses on the van and station worksheets.

3. Audit Point 2: Cursor to "O3" on the front panel of the calibrator and enter a "Level 1" concentration for (0.400 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

   NOTE: Make certain the calibrator updates after pressing the "UPDATE" button. Observe the "TARGET" and "ACTUAL" ozone values on the front panel display of the calibrator. These values should be identical. If they are not, press "UPDATE" again.

4. Audit Points 3 and 4: Follow the same procedure as "Audit Point 2" for the "Level 2" and "Level 3" audit points (0.175 ppm and 0.070 ppm). When the van and station readings are stable, record the responses on the van and station worksheets.

5. Audit Point 5: Cursor to "O3" on the front panel of the calibrator and enter zero (0.000 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

6. Press "STOP" on the front panel of the calibrator. Press "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" switch on the solenoid control panel to the "OFF" (green light off) position.

7. Enter the van and station ozone responses into the audit program for final calculation and print out.

NOTE: All responses may be entered after each audit point.

E.1.2.3 AUDIT VAN CARBON MONOXIDE ANALYZER CALIBRATION PROCEDURE

The TECO 48c is used during a performance audit to analyze the amount of CO present in a diluted gas sample. Prior to each audit (pre-), the TECO 48c is calibrated using Ultrapure Air, API 701 zero air, and NIST traceable CO gases at concentrations of 7 ppm and 40 ppm. The TECO 48c is rechecked following the performance audit (post-), using Ultrapure Air, API 701 zero air and NIST traceable CO gas at 40 ppm. The pre- and post- TECO 48c analyzer responses are averaged to obtain true CO concentrations.

NOTE: All van TECO 48c responses are to be entered into the computer and on the van worksheet under the "Van CO Analyzer Responses".

Two multi-port glass manifolds are used during a performance audit. The "Front Manifold" is used to supply the van instruments with API 701 zero air, Ultrapure Zero Air, CO and NO calibration gases, or diluted gas samples. The "Rear Manifold" supplies the station with zero air or diluted audit gases.

A three-way solenoid valve is used to direct the sample flow of the "Rear Manifold", when in the ENVIRON/STAND-BY Mode, or "Calibration" gases, when in the CAL-LINE Mode.

"ENVIRON" Mode - A ¼" Teflon line is connected from the rear manifold to a three-way solenoid valve. A ¼" Teflon line is then connected from the three-way solenoid valve to a needle valve. Another ¼" Teflon line is connected from the needle valve to the front manifold.

"CAL-LINE" Mode - A ¼" or 1/8" Teflon line is connected from the audit van's CO, NO, and Ultrapure Air cylinder to a pressure regulator. From the pressure regulator it is connected to a three-way solenoid valve. A ¼" Teflon line is then connected from the solenoid valve to the front manifold.

1. Allow the TECO 48c to warm-up for at least 3½ hours.

2. If an ozone audit was conducted prior to the TECO 48c calibration, turn the power to the API 400a "OFF". Readjust the flow to the by-pass rotameter until 0.3-0.4 lpm is indicated.

3. If an ozone audit was not conducted prior to the TECO 48c calibration, place the "ENVIRON" switch on the solenoid control panel in the "ON" (green light on) position to direct flow to the calibrator. With the calibrator in the "READY" mode, press "UPDATE".

4. Readjust the flow to the by-pass rotameter, using the by-pass flow needle valve, until 0.3-0.4 lpm is indicated.

5. Once the TECO 48c response to the API 701 zero air is stable, record the result on the van worksheet under "Pre-Audit Responses, API 701". If the response is not within ± 0.5 ppm, readjust the zero as follows:

   a. Press the button on the TECO 48c that reads "MENU".

   b. Using the down arrow, scroll down until "Calibration" is displayed, and press "ENTER".

   c. Scroll down until "Calibrate Zero" is displayed and press "ENTER". The TECO 48c will reset the current response to zero.

   CAUTION: Make certain the TECO 48c has warmed-up for at least 3 ½ hours on API 701 zero air before performing this action. If the initial zero is greater than ± 0.6 ppm, rerun the zero using Ultrapure air. If the zero response remains the same, proceed with the zero recalibration (provided the response is not greater than 1.0 ppm). If the TECO 48c response returns to zero using the Ultrapure air, do not reset the zero values. Use the actual value obtained from the API 701 as the zero response.

   d. Press "RUN" to return the TECO 48c to the sample mode.

6. Allow the TECO 48c to restabilize. When the response to zero air is stable, mark the chart and record the result on the van worksheet under "Pre-Audit Responses, API 701".

7. Toggle the "CAL" and "HIGH CO" switches on the solenoid control panel to the "ON" (green lights on) position. Open the valve on the High CO gas cylinder and adjust the pressure regulator on the instrument rack until a 0.3 to 0.4 lpm flow is indicated on the by-pass flow rotameter.

8. Once the CO response is stable, record the result on the van worksheet under "Pre-Audit Responses, High CO". If the CO response is not within ± 1.0 ppm, readjust the span value as follows:

    a. Press the "MENU" button on the TECO 48c.

    b. Using the down arrow, scroll down until "Calibration" is displayed and press "ENTER".

    c. Scroll down until "Calibrate Span" is displayed. If the correct span value is displayed, press "ENTER". If the correct span value is not displayed, use the → arrow to scroll over and enter the correct value. The up ↑ and down ↓ arrows will change this value. When the correct value is displayed, press "ENTER". The TECO 48c will reset the span value.

    d. To return to the "Sample Mode", press "RUN".

9. Allow the TECO 48c to stabilize. When the CO response is stable, record the result on the van worksheet under "Pre-Audit Responses, High CO".

10. Toggle "OFF" the "HIGH CO" switch and toggle "ON" the "LOW CO" switch on the solenoid control panel. Open the valve on the Low CO gas cylinder and adjust the pressure regulator until a 0.3 to 0.4 lpm by-pass flow is indicated on the rotameter.

11. When the "Low CO" response is stable, record the result on the van worksheet under "Pre-Audit Responses, Low CO".

12. Toggle "OFF" the "LOW CO" switch and toggle "ON" the ULTRAPURE" switch on the solenoid control panel. Open the valve on the Ultrapure gas cylinder and adjust the pressure regulator until a 0.3-0.4 lpm by-pass flow is indicated on the rotameter.

13. When the CO response is stable, record the result on the van worksheet under "Pre-Audit Responses, Ultrapure".

14. Toggle the "CAL" and "ULTRAPURE" switches on the solenoid control panel to the "OFF" (green lights off) position.

15. To conduct a Carbon Monoxide Performance Audit, continue to Section E.1.2.4.

E.1.2.4 CARBON MONOXIDE AUDIT PROCEDURE

Ambient level concentrations for each pollutant are determined by multiplying the concentration value for each pollutant by the CO dilution ratio obtained at each audit level. This is illustrated by the following formulae:

$$\text{Dilution Ratio} = \frac{(\text{CO response} - \text{Zero}) \times \text{CO Analyzer Slope} + \text{CO analyzer Intercept}}{\text{Superblend CO Concentration}}$$

Values for NO, NOX, SO2 and CH4 (in ppm) = Dilution ratio x Superblend #1 value for that pollutant.

1. Calibrate the TECO 48c as outlined in Section E.1.2.3.

2. With the calibrator in the "READY" mode "CONC MODE" displayed on the lower left button), press the "MAINTAIN PORTS" button to confirm that the current quarter gas standards have been entered into the calibrator. If the standards were not updated, Enter "2" (Superblend #1 port) and press "ACCEPT". Enter the Superblend concentrations for CO, NO, SO2, and CH4. Enter the cylinder ID#. Press the "EXIT" button twice to return to the "READY" mode.

3. Press the "CONC MODE" button on the front panel of the calibrator. Verify that the calibrator is displaying "MFC Port 2". If not, cursor over and enter "2". Cursor to "TARGET FLOW" and enter "16.0" if it is not displayed. Cursor to the "TARGET GAS" and enter "0.0" if it is not displayed.

4. CO Audit Point 1: Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position. Press the "START" button on the front panel of the calibrator. After a few minutes, adjust the by-pass flow rotameter until a 0.3-0.4 lpm by-pass flow is indicated.

   CAUTIION: When conducting performance audits using Superblend #1, open the valve on the SB#1 cylinder. When pressure is indicated on the pressure regulator, reclose the valve. Disconnect the stainless steel line at the regulator by releasing the quick-connect. Using an open quick-connect, bleed the gas from the pressure regulator until there is zero pressure indicated. Repeat this step two more times. This will evacuate any NO2 that has accumulated in the regulator.

5. Allow the audit van and the station analyzer to stabilize on zero air. Once the analyzer readings are stable (a stable 10 minute trace), record the responses on the van and station worksheets.

6. Open the valve on the SB #1 cylinder and adjust the regulator to 20 psi. Toggle the "SB #1" switch on the solenoid control panel to the "ON" (green light on) position.

7. CO Audit Point 2: Using the arrow keys, move the cursor on the front panel of the calibrator to "CO" and enter "40.0", which corresponds to 40 ppm (High CO audit point). Press the "UPDATE" button. When the van and station analyzer readings are stable, record the responses on the van and station worksheets.

8. CO Audit Points 3 through 5: Repeat Steps 7 and 8 for the "Middle," "Low," and "Post-Zero" audit points (typically 17.5 ppm, 7.0 ppm, and 0.00 ppm). When the readings are stable, record the responses on the van and station worksheets.

9. Toggle the "CAL" and "HIGH CO" switches on the solenoid control panel to the "ON" (green light on) position. Open the "HIGH CO" calibration gas cylinder and adjust the regulator until a 0.3-0.4 lpm by-pass flow is obtained. When the reading is stable, record the response on the van worksheet under "Post-Audit High CO".

10. Toggle the "HIGH CO" switch to the "OFF" position and the "ULTRAPURE" switch to the "ON" position. Open the "Ultrapure" gas cylinder and adjust the regulator until a 0.3-0.4 lpm by-pass flow is indicated. When the reading is stable, record the response on the van worksheet under "Post-Audit Ultrapure".

11. Toggle the "CAL" and "ULTRAPURE" switches to the "OFF" position. Close the valves on all gas cylinders.

12. Press "STOP" on the front panel of the calibrator, and then "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" and "SB #1" switches to the "OFF" (green light off) position.

13. Enter the data into the audit van program for final calculation and report printing. Turn all equipment off.

E.1.2.5 HYDROGEN SULFIDE (H2S) AUDIT PROCEDURE

1. With the calibrator in the "READY" mode ("CONC MODE" displayed on the lower left button), press the "MAINTAIN PORTS" button.

Enter "3" (the Superblend #2/3 port in Van "A") or (Superblend #3 port in Van "B") and press "ACCEPT". Enter the concentrations for H2S and CO. Enter the cylinder ID#. Press the "EXIT" button twice to return to the "READY" mode.

2. Press the "CONC MODE" button on the front panel of the calibrator. Cursor to "TARGET FLOW" and enter "16.0" if not displayed. Cursor to "TARGET GAS" and enter "0.0" if not displayed. Press "UPDATE". Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position to direct zero air to the calibrator.

3. Press the "START" button on the front panel of the Calibrator to deliver zero air to the van and station instruments. Adjust the flow to the by-pass rotameter until 0.3-0.4 lpm is indicated.

4. Calibrate the TECO 48c as outlined in Section E.1.2.3.

5. Audit Point 1: When the van and station zero responses are stable (ten minute stable trace), record the readings on the van and station worksheets.

NOTE: If the H2S analyzer is operating on the 0 to 1 ppm range, generate an "Opt High" point in the 0.800 to 0.900 ppm range. This will add an additional audit point (see Table E.1.2.1).

6. Audit Point 2: Cursor to "H2S" and enter the "High" point concentration (0.400 ppm). Press the "UPDATE" button on the calibrator. When the van and station responses are stable, record them on the van and station worksheets.

   NOTE: Make certain the calibrator updates after pressing the "UPDATE" button. Observe the calibrator "TARGET" and "ACTUAL" gas values on the front panel display. These values should be the same (± 2%). If not, press "UPDATE" again.

7. Audit Points 3 and 4: Follow the same procedure as "Audit Point 2" for the "Middle" and "Low" audit points (0.175 ppm and 0.070 ppm respectively).

8. Audit Point 5: Cursor to "H2S" and enter zero (0.000 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

9. Press "STOP" on the front panel of the calibrator. Press "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" switch on the solenoid control panel to the "OFF" (green light off) position.

10. Toggle the "CAL" and "HIGH CO" switches on the solenoid control panel to the "ON" (green light on) position. Open the valve on the "HIGH CO" gas cylinder and adjust the regulator to obtain a 0.3-0.4 lpm by-pass flow as indicated on the by-pass rotameter. When the van CO reading is stable, record the response on the van worksheet under "Post-Audit Responses, High CO".

11. Toggle the "HIGH CO" switch on the solenoid control panel to the "OFF" (green light off) position. Toggle the "ULTRAPURE" switch to the "ON" (green light on) position. Open the valve on the "ULTRAPURE" gas cylinder and adjust the regulator to obtain a 0.3-0.4 lpm by-pass flow. When the van CO reading is stable, record the response on the van worksheet under "Post-Audit Responses, Ultrapure ".

12. When the station reading is stable, record the response on the station worksheet. Press "STOP" on the front panel of the calibrator. Press "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" switch on the solenoid control panel to the "OFF" (green light off) position.

13. Enter the data into the van audit program for recalculation and audit report printing. Turn all equipment off.

E.1.2.6 NON-METHANE HYDROCARBON AUDIT PROCEDURE (NMHC)

1. With the Calibrator in the "READY" mode ("CONC MODE" displayed on the lower left button), press the "MAINTAIN PORTS" button. Enter "3" (the Superblend #2 and 3 port in Van "A") or "4" (Superblend #3 port in Van "B") and press "ACCEPT". Enter the concentrations for CO and C3H8. Enter the cylinder ID#. Press the "EXIT" button twice to return to the "READY" mode.

2. Press the "CONC MODE" button on the front panel of the calibrator. Cursor to "TARGET FLOW" and enter "16.0", if not displayed. Cursor to "TARGET GAS" and enter "0.0", if not displayed. Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position to direct dilution air to the calibrator.

3. Press the "START" button on the front panel of the calibrator to deliver zero air to the van and station instruments. Adjust the flow to the by-pass rotameter until a flow of 0.3-0.4 lpm is indicated.

4. Calibrate the TECO 48c as outlined in Section E.1.2.3.

5. Audit Point 1: Open the valve on the "SB#3" cylinder and adjust the pressure regulator to 30 psi. When the van and station zero readings are stable, (ten minute stable trace), record the responses on the van and station worksheets.

6. Audit Point 2: Cursor to "C3H8" on the front panel of the calibrator and enter a "High" point concentration (1.80 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

   NOTE: Make certain the calibrator updates each time the "UPDATE" button is pressed. Observe the calibrator "TARGET" and "ACTUAL" gas values on the front panel display. These values should be the same (± 2%). If the values are not the same, press "UPDATE" again.

7. Audit Points 3 through 5: Follow the same procedure outlined in "Audit Point 2" for the "Middle," "Low," and "Post-Zero" audit points (1.20 ppm, 0.60 ppm, and 0.00 ppm respectively).

8. Toggle the "CAL" and "HIGH CO" switches on the solenoid control panel to the "ON" (green light on) position. Open the valve on the "HIGH CO" gas cylinder and adjust the regulator to obtain a 0.3-0.4 lpm by-pass flow as indicated on the by-pass rotameter. When the van CO reading is stable, record the response on the van worksheet under "Post-Audit Responses, High CO".

9. Toggle the "HIGH CO" switch on the solenoid control panel to the "OFF" (green light off) position. Toggle the "ULTRAPURE" switch to the "ON" (green light on) position. Open the valve on the "ULTRAPURE" gas cylinder and adjust the regulator to obtain a 0.3-0.4 lpm by-pass flow. When the van CO reading is stable, record the response on the van worksheet under "Post-Audit Responses, Ultrapure ".

10. When the station reading is stable, record the response on the station worksheet. Press "STOP" on the front panel of the calibrator. Press "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" switch on the solenoid control panel to the "OFF" (green light off) position.

11. Toggle the "ULTRAPURE" switch to the "OFF" position. Close the valves on all gas cylinders.

12. Enter the data into the van audit program for recalculation and audit report printing. Turn all equipment off.

E.1.2.7 FULL AUDIT PROCEDURE

1. Calibrate the TECO 48c as outlined in Section E.1.2.3.

2. With the calibrator in the "READY MODE" ("CONC MODE" displayed on the lower left button), press the "MAINTAIN PORTS" button. Enter "2" (Superblend #1 Port) and press "ACCEPT". Enter the Superblend #1 concentrations for CO, NO, SO2, and CH4. Enter the cylinder identification number, if needed. If these parameters were previously entered, check them against the current certification values to make certain they were entered correctly. Press the "EXIT" button twice to return to the "READY" mode.

3. Press the "CONC MODE" button on the front panel of the calibrator to enter the concentration mode. If "MFC Port 2" is not displayed, cursor to the "MFC Port" and enter "2". Cursor to "TARGET FLOW" and enter "16.0" unless it is displayed. Cursor to "TARGET GAS" NO and enter "0.0" unless it is displayed. Cursor to "O3" and enter "0.000" unless it is displayed. Press "UPDATE". Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position.

4. Press "START" on the front panel of the calibrator to deliver zero air to the van and station instruments. Adjust the flow to the by-pass rotameter until a flow of 0.3-0.4 lpm is indicated.

5. Audit Point 1: When the van and station responses are stable, record the responses on the audit van and station worksheets.

   NOTE: Before starting Audit Point 2, check the operating range of the station's NO/NOX instrument. If the NO/NOX instrument is operating on a range less than 0-1 ppm, disconnect the instrument from the manifold and cap the open manifold port. The instrument may be reconnected to the manifold when the target vales for NO/NOX are within the instruments' operating range.

6. Audit Point 2: Open the "SB#1" gas cylinder and adjust the pressure regulator to 30 psi. Toggle the "SB #1" switch on the solenoid control panel to the "ON" (green light on) position. Cursor to "TARGET GAS" on the front panel of the calibrator and enter a "HIGH NO" concentration (0.800-0.900 ppm) for analyzers operating on the 0-1 ppm range. This point is used for the NO linear regression and "Level 1" concentrations for CO (35-45 ppm), (SO2 (0.350-0.450 ppm) and (CH4 (16-20 ppm). Press the "UPDATE" button on the front panel of the calibrator. When the audit van and station readings are stable, record the responses on the van and station worksheets.

   NOTE: During most performance audits, NO values are entered to achieve audit level concentrations of NO/NOX, CO, SO2, and CH4 (See Table E.1.2.1). If NO/NOX instruments are not present, CO values are entered to achieve audit level concentrations of CO, SO2, and CH4.

7. Audit Point 3: Cursor to "TARGET GAS" NO on the front panel of the calibrator and enter a "Level 1" NO value (typically 0.450-0.500 ppm). This is also used for "Level 2" concentration for CO (15-20 ppm), SO2 (0.150-0.200 ppm) and CH4 (10-15 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

8. Audit Point 4: Without changing the concentrations, cursor to "Ozone" on the front panel of the calibrator and enter a "Level 1" titration point (typically 0.400 obtain 0.400 ppm of NO2). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets. Cursor to "Ozone" on the front panel of the calibrator and enter "0.000". Press "UPDATE".

9. Audit Point 5: Audit point for NO2 only. Cursor to "TARGET GAS" NO on the front panel of the calibrator and enter a "Level 2" NO value (typically 0.275 ppm). Press "UPDATE" on the front panel of the calibrator. When the van and station readings are stable, record the responses audit van and station worksheets.

10. Audit Point 6: Audit point for NO2 only. Without changing the concentrations, cursor to "Ozone" on the front panel of the calibrator and enter a "Level 2" titration point (typically 0.175 to obtain 0.175 ppm of NO2). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets. Cursor to "Ozone" on the front panel of the calibrator and enter "0.000". Press "UPDATE".

11. Audit Point 7: Cursor to "TARGET GAS" NO on the front panel of the calibrator and enter a "Level 3" NO concentration (typically 0.170 ppm). This is also used for "Level 3" concentrations of CO (03-08 ppm), SO2 (0.03-0.08 ppm) and CH4 (3-8 ppm). Press "UPDATE". When the van and station readings are stable, record the responses on the van and station worksheets.

12. Audit Point 8: Without changing the concentrations, cursor to "Ozone" on the front panel of the calibrator and enter a "Level 3" titration point (typically 0.070 to obtain 0.070 ppm of NO2). Press "UPDATE". When the audit van and station responses are stable, record the results on the audit van and station worksheets. Cursor to "Ozone" on the front panel of the calibrator and enter "0.000". Press "UPDATE".

    NOTE: Audit Point 9 (Option): Linear regression point for station NO/NOX instruments operating on the 0.0-0.5 ppm range. Cursor to "O3" on the front panel of the calibrator and enter "0.000". Press "UPDATE". Cursor to "TARGET GAS" NO on the front panel of the calibrator and enter an "OPTIONAL" level (typically 0.06 ppm). Press "UPDATE". When the van and station responses are stable, record the results on the van and station worksheets.

13. Audit Point 9/10: Move the cursor on the front panel of the calibrator to "TARGET GAS" NO, enter "0.0". Press "UPDATE". Toggle the SB#1 switch on the solenoid control panel to the "OFF" (green light off) position. When the audit van and station responses are stable, record the results on the audit van and station worksheets.

14. Toggle the "CAL" and "HIGH CO" switches on the solenoid control panel to the "ON" (green lights on) position. Open the valve on the "HIGH CO" gas cylinder and adjust the pressure regulator on the instrument rack to obtain a 0.3-0.4 lpm by-pass flow. When the van CO reading is stable, record the response on the van worksheet under "Post-Audit Responses, High CO".

15. Toggle the "HIGH CO" switch on the solenoid control panel to the "OFF" position and toggle the "ULTRAPURE" switch to the "ON" position. Open the valve on the "ULTRAPURE" gas cylinder and adjust the cylinder pressure regulator to obtain a 0.3-0.4 lpm by-pass flow. When the van CO reading is stable, record the response on the van worksheet under "Ultrapure, Post-Audit Responses".

16. Toggle the "ULTRAPURE" and the "CAL" switches on the solenoid control panel to the "OFF" position. Close the valves on all gas cylinders.

17. Press "STOP" on the front panel of the calibrator. Press "EXIT" to return the calibrator to the "READY" mode. Toggle the "ENVIRON" switch on the control panel to the "OFF" position.

18. Enter the data into the van audit program for recalculation and audit report printing. Turn all equipment off.

E.1.2.8 Converter Efficiency/True Pollutant Concentrations

1. Converter Efficiency: The converted NO2 concentration is used at each point to determine NO/NOX analyzer converter efficiency. The converter efficiency is calculated as follows:

$$\% \text{ CE} = \frac{\Delta\text{NO} - \Delta\text{NOX}}{\Delta\text{NO}} \times 100$$

Where: CE = Converter Efficiency

Where: ΔNO = ([NO] original – [NO] remainder) / NO Slope

Where ΔNOX = ([NOX] original – [NOX] remainder) / NOX Slope

If the derived converter efficiency falls below 96%, an Air Quality Data Action (AQDA) request will be issued. All data will be deleted for the period of time that the converter efficiency is outside the 96% or greater converter efficiency control limit.

2. True Pollutant Concentrations: Ambient level concentrations for each pollutant are determined by multiplying a dilution ratio by the concentration value for each pollutant at each audit level. The dilution ratio and ambient level concentrations are determined using the following formulae:

$$\text{Dilution Ratio} = \frac{(\text{Van CO} - \text{Van Zero}) \times \text{CO Slope} + \text{CO Analyzer Intercept}}{\text{Superblend CO Concentration Value}}$$

Values for NO, NOX, SO2, H2S, C3H8 (in ppb) = Dilution Ratio x Superblend Concentration Value

3. True NO2 Concentrations: True ambient level concentrations for NO2 are calculated using the following formulae:

$$\text{Van NO2} = \frac{\text{NO (Ozone Off)} - \text{NO (Ozone On)}}{\text{NO Slope}}$$

Station NO2 = (NOX [Ozone On] – NOX Zero Average) – (NO [Ozone On] – NO Zero Average)

Site Name: _____ Site Number: _____ Date: _____

Address: _____ Site Phone Number: _____

Data Read From: Chart[ ] DAS[ ] Other[ ] Type: _____

Zero Correction: [ ] N[ ] Booster Pump: Y[ ] N[ ] Booster Pump Flow Rate: _____

Station Manifold Pressure: Before Audit: _____ During Audit: _____

Instrument Range and Response

								Ozone Off		Ozone On	
Audit Point	O3	CO	THC	CH4	NMHC	SO2	H2S	NO	NOX	NO	NOX
Range (ppm)											
Pre-Zero											
High-1st Pt.											
Med-2nd Pt											
Nox-1st Pt.											
NOX-2nd Pt.											
Low-3rd Pt.											
NOX-Opt Pt.											
Post-Zero											

Station Instrument Information

Instruments	Ozone	CO	NMHC	SO2/H2S	NO/NOX
Manufacturer					
Model Number					
Property Number					
Calibration Date					
EPA Equivalency #					
Slope/Intercept					
Indicated Flow					
In-Line Filter Change					
		Converter Temperature			

Calibration Equipment

Equipment	Equipment Type	Identification Number	Certification Date
Calibration Gas			
Hi-Vol Calibrator			
Gas Calibrator			
Ozone Generator			

Figure E.1.2.1
QA Audit Station Data Worksheet

Site Name: _____ Date: _____

Site Number: _____ Auditors: _____

Van: A[ ] B[ ] C[ ] D[ ] E[ ] Van Flow: _____ Station Flow: _____

Quarter: 1[ ] 2[ ] 3[ ] 4[ ] Standards Version: _____ Year: _____

Van Ozone Responses					
Audit Point	1	2	3	4	5
Ozone Setting	0	400	175	70	0
Display Reading					

Van CO Calibration Responses							
Pre-Audit Responses					Post-Audit Responses		
API 701	High CO	Low CO	Ultrapure		API 701	High CO	Ultrapure

Van CO Dilution Responses								
Audit Point	Audit Mode	Target Ozone	Target		Actual		CO Set Point	CO Display Reading
			Air	Gas	Air	Gas		
	Pre-Zero							
	High							
	Middle							
	NO2							
	Option							
	NO2							
	Low							
	NO2							
	Opt NO							
	Post-Zero							

Figure 1.2.2
QA Audit Van Data Worksheet

AUDIT STANDARDS DATASHEET

Superblend #1	Superblend #2	Superblend #3
CO = 15,000 ppm	CO = 15,000 ppm	CO = 14, 000 ppm
NO = 325 ppm	H2S = 325 ppm	C3H8 = 612 ppm
SO2 = 150 ppm		

Ambient Level Gases
7 ppm and 45 ppm CO
Ultra-Pure Zero Air
NIST Traceable
Calibration Standards

*************ALL CYLINDER CONCENTRATIONS ARE APPROXIMATE*************

Environics 9100 Gas Calibrator with Ozone Generator	API 400a Ozone Analyzer	TECO 48c CO Analyzer (0 – 50 ppm)

AIR FLOW = 16 LITERS PER MINUTE

DULUTED CONCENTRATIONS

CO, NO, SO2, H2S, C3H8

AUDIT VAN DELIVERY SYSTEM

$$\text{DILUTION RATIO} = \frac{\text{True CO Response}}{\text{Superblend Cylinder CO Concentration (ppm)}}$$

AIR MONITORING STATION INLET PROBE

TRUE CONCENTRATION = Superblend Concentrations x Dilution Ratio

Figure E.1.2.3
Audit Standards Datasheet

TABLE E.1.2.1
LEVELS OF POLLUTANT CONCENTRATION (PPM)

Audit Point	Ozone (ppm)
1	Zero
2	0.35 – 0.45
3	0.15 – 0.20
4	0.03 – 0.08
5	Zero

Audit	Ozone **OFF**		Ozone **ON**							
Point	NO	NOX	NO	NOX	NO2	CO	CH4	SO2	H2S	C3H8
1	Zero	Zero				Zero	Zero	Zero	Zero	Zero
2	*0.900	0.900				35 – 45	15 - 20	.35 - .45	.35 - .45	0 – 1.8
3	**0.450	0.450				15 – 20	10 - 15	.15 - .20	.15 - .20	0 – 1.2
4				0.450					.03 - .08	0 – 0.6
5	0.275	0.275							Zero	Zero
6			0.100							
7	0.170	0.170				03 – 08	03 - 08	.03 - .08		
8			0.100	0.170	0.070					
9	0.070	0.070								
10	Zero	Zero				Zero	Zero	Zero		

* Indicates Point 1 for NO/NOX analyzers operating on the 0 - 1.0 ppm range.
** Indicates Point 1 for NO/NOX analyzers operating on the 0 – 0.5 ppm range.

Audit Level	Ozone	NO/NOX	CO	SO2	CH4	H2S	C3H8
1	0.35 - 0.45	0.35 - 0.45	35 - 45	0.35 0.45	15 - 20	0.35 0.45	0 - 1.8
2	0.15 - 0.20	0.15 - 0.20	15 - 20	0.15 - 0.20	10 – 15	0.15 - 0.20	0 - 1.2
3	0.03 - 0. 08	0.03 - 0.08	03 - 08	0.03 - 0.08	03 – 08	0.03 - 0.08	0 - 0.6

E.1.2.9 PERFORMANCE AUDIT FAILURES

1. In the event of a failed audit, an investigation is necessary to determine the possible cause of the failure. It may be necessary to inspect everything, beginning with the van operation and ending with the station operation.

   NOTE: If the cause for the failure is determined during any point in the investigation, resolve the problem (if possible) and resume the audit. The site operator should be notified of the "As Is" failure. If the cause of the failure is determined to be the audit van set up, the problem should be resolved and the audit restarted. Delete the results of the first audit.

2. Beginning with the audit van, all instruments need to be checked to verify proper operation. This will include all of the following, unless the cause of the failure is discovered and resolved at any point during the investigation process.

   a. Van Calibrator. If conducting an ozone audit, is the airflow set correctly? What values do the mass flow controllers indicate? Is the correct ozone value selected for the appropriate audit point? Does the display of the API 400a indicate the correct ozone level?

   b. If conducting a gaseous audit. Is the airflow set correctly? What value do the mass flow controllers indicate? Does the TECO 48c indicate the correct CO range? Is the correct CO range selected on the Environics 9100 calibrator?

   c. Is the compressor in the API 701 running? Is there sufficient output pressure (40-45 psi) to maintain a constant pressure of 30-35 psi to the Environics 9100 calibrator? Is the regulator pressure set at 35-40 psi? Is there sufficient pressure in the gas cylinder (at least 200 psi)? Is the by-pass rotameter set for a flow of 0.3-0.4 lpm? Is the correct gas port selected?

   d. Are all lines correctly connected to the manifolds? Are the lines to the instruments connected? Are there any apparent leaks? Are the filters installed correctly?

3. When these checks have been completed and all instruments checked for proper operation, the next step is to verify that the station is receiving enough flow to their inlet probe. This flow can be easily checked with a mass flow meter. If there is not enough flow to the inlet probe, disconnect any booster pump that the station may be using. The van flow needs to be at least 1 lpm greater than the station flow requirement.

4. If the cause for the failure still can not be determined, check the flow path of the audit gas from the station inlet probe to the back of the station instruments. Make certain to check all lines and in-line filters for leaks or breaks.

5. If the cause for the failure can not be determined during this examination, remove the "Line" from the station inlet probe and connect it to the station's instrument manifold. Recheck the instruments for the proper response.

6. If the instrument still indicates a failure, remove the "Line" from the instrument manifold and check for the response at the back of the instrument using a glass tee and a by-pass.

7. If the cause for the failed condition can not be determined after a thorough investigation, draw a diagram of the audit set-up. The diagram should show how the "Line" is connected to the station's inlet probe and the sampling system from the inlet probe to the instruments. Include a brief comment on all trouble shooting measures performed.

8. When the investigation is completed, issue an AQDA as described in Section E.1.3.2.

E.1.3 POST-AUDIT PROCEDURES

E.1.3.1 PRINTING AUDIT RESULTS

1. After the final Ozone point or CO calibration, verify that all audit van and station responses have been accurately recorded on the van and station audit worksheets.

2. Access the audit program to be used and verify that all van and station information has been entered correctly.

3. Print out two copies of the audit report. Give one copy to the station operator and retain one copy for ARB use.

4. Remove the strip chart trace from the van's Yokogawa chart recorder. Record the site name, number, date, and auditor's names on it. Attach the chart, along with all van and station worksheets, to the ARB copy of the audit results.

E.1.3.2 AIR QUALITY DATA ACTION (AQDA) REQUEST

1. After returning to the office, obtain an AQDA form and fill it out in its entirety, including the audit date, instrument(s) failed, reason for the failure, and a suggested period for data correction/deletion.

2. Mail a copy of the completed AQDA to the site operator, requesting that the AQDA be resolved within a reasonable time (usually 30 days).

NOTE: AQDA's are issued when the audit reveals that the station's instrument(s) are not operating within the control limits defined in EPA's Volume II.

If the station has failed the audit, or a portion of the audit, it will be necessary to issue an AQDA (Figure E.1.3.1).

AIR QUALITY DATA ACTION REQUEST

(For ARB Use Only)

SITE NAME: _____ REQUEST LOG#: _____

SITE NUMBER: _____ AIRS#: _____ REQUEST DATE: _____

TO: _____, Air Monitoring/APCD. Please investigate the potential inaccuracies listed below* and recommend appropriate action/s. If no response to this action is received by _____ QA staff shall review and recommend appropriate action/s.

TO: _____, Air Quality Data Review. Please withhold the following air quality data from processing until potential data inaccuracies are resolved.

FROM: _____, Quality Assurance Section.

* Potential Data Inaccuracies

POLLUTANT	EST. TIME PERIOD *			REASON FOR ACTION
	FROM:			
	Month	Day	Year	
CODE	TO:			
See Attached List	Month	Day	Year	

Air Monitoring/APCD to complete the following block from their quality control records, sign, and return to the Quality Assurance Section. * Exact interval to be determined by district.

RECOMMENDED DATA ACTION		TIME PERIOD (INCLUSIVE)					±CORRECTION FACTOR
RELEASE:		BEGIN:					
CORRECT±:		END:					* NULL CODE
INVALIDATE *:			HOUR	MONTH	DAY	YEAR	

JUSTIFICATION

REVIEWED BY:
1. _____ DATE: _____
2. _____ DATE: _____
3. _____ DATE: _____
4. _____ DATE: _____

The recommended data actions were applied and the air quality data were uploaded on the AIRS/ADAM Database by _____ on _____.

Figure E.1.3.1
AQDA Form

E.1.4 SHUT DOWN PROCEDURES – AUDIT VAN

E.1.4.1 INTERIOR

1. After printing the audit report, exit the computer program and shut down the computer.

2. Turn off the power to the printer and chart recorder.

3. Turn off the power to the Environics 9100 calibrator, API 400a, TECO 48c, and TECO 42c.

4. Turn off the power to the API 701 zero air system.

5. Close the valves on all compressed gas cylinders.

6. Turn off the power to the Elgar or Powerware voltage and line conditioner.

7. Turn off the air conditioning units.

8. After shutting off all overhead lighting, turn off the generator.

E.1.4.2 EXTERIOR

1. Remove the "Line" from the station's inlet probe.

2. Reel the "Line" into the audit van and cap the end. Make certain the end of the "Line" is placed into the "Line" cradle, and lock the hose reel into position.

3. Secure the ladder and safety cones.

4. Remove the wheel chocks.

E.1.5 CALIBRATION CHECKS AND PROCEDURES

E.1.5.1 QUARTERLY "OZONE LINE LOSS" TEST START-UP

The "Ozone Line Loss" test is conducted quarterly to determine the actual ozone concentration being delivered to the station's inlet probe. By analyzing the ozone concentration before and after the "Line", it is possible to determine the actual amount of ozone loss attributed to the "Line". This loss percentage is used to correct for "true" ozone, so as not to bias audit results.

1. Plug in the audit van "Land" line or start the generator.
2. Make certain the Land Line/Generator switch is in the correct position.
3. Turn on the power to the Elgar/Powerware, API 701, Environics 9100, API 400a, and the Yokogawa chart recorder.
4. Make certain that the chart recorder is logging. If not, press "Start".
5. Record the date of the test, vehicle the test is being conducted in, and the name of the person conducting the test.
6. Make certain that all the above instruments are "ON" and operating properly.

E.1.5.2 CONDUCTING THE QUARTERLY "OZONE LINE LOSS" TEST

Two lines are used during the quarterly "Ozone Line Loss" test. These will be referred to as the "Inside" and "Outside" lines.

INSIDE: ¼" Teflon line from the instrument port of the rear manifold to the calibration port of the front manifold.

OUTSIDE: ½" by 150' stainless steel braided line with a needle valve, stainless steel tee, and 2' of Teflon line.

NOTE: The van also uses two glass manifolds for gas distribution to the van and station instruments. The "rear" manifold supplies audit gas concentrations to the station and a portion of the sample is supplied to the "front" manifold through a three-way solenoid valve which supplies the Ozone, NOX, and CO instruments.

1. Allow the API 701, API 400a, and the Environics 9100 calibrator (calibrator) to warm-up for at least one hour prior to conducting the "Ozone Line Loss" test.

2. Uncap the audit van "Line", remove the 2' Teflon line, and attach the test equipment to the end of the "Line". Reattach the 2' Teflon line.

3. With the calibrator in the "READY" mode ("CONC MODE" displayed on the lower left button), press "CONC MODE " on the front panel of the calibrator. Using the arrow keys, cursor to "TOTAL FLOW" and enter "16.0" if not displayed. Cursor to "TARGET GAS" CO and enter "0.0" if not displayed. Cursor to "O3" and enter "0.000" if not displayed. Toggle the "ENVIRON" switch on the solenoid control panel to the "ON" (green light on) position. Press the "START" button on the front panel of the calibrator to deliver zero air to the "outside" line.

4. With the "Inside" line connected to the front manifold, adjust the flow to the rotameter until a by-pass flow of 0.3-0.4 lpm is indicated.

5. Disconnect the "Inside" line from the front manifold and connect the "Outside" line. Using the needle valve on the test equipment, adjust the flow to the rotameter until a 0.3-0.4 lpm by-pass flow is indicated.

6. Disconnect the "Outside" line and reconnect the "Inside" line. Readjust the by-pass flow if necessary. Allow sufficient time to establish a stable trace on the chart recorder (at least 10 minutes). Record the API 400a response on the Quarterly Ozone Line Loss Test Form (Figure E.1.5.1).

7. Disconnect the "Inside" line and reconnect the "Outside" line. Readjust the by-pass flow if necessary. Allow sufficient time to establish a stable trace on the chart recorder. Record the API 400a response.

8. Disconnect the "Outside" line and reconnect the "Inside" line. Readjust the by-pass flow if necessary. Cursor down to "O3" on the front panel of the calibrator and enter "0.400". Press "UPDATE". Allow sufficient time for a stable trace and record the API 400a response.

9. Disconnect the "Inside" line and reconnect the "Outside" line. Readjust the by-pass flow if necessary. Allow sufficient time for a stable trace and record the API 400a response.

10. Cursor to "O3" on the front panel of the calibrator and enter "0.175". Press "UPDATE".

11. Repeat steps 6 and 7.

12. Cursor to "O3" on the front panel of the calibrator and enter "0.070". Press "UPDATE".

13. Repeat steps 6 and 7.

14. Cursor to "O3" on the front panel of the calibrator and enter "0.000". Press "UPDATE".

15. Repeat steps 6 and 7.

16. Calculate the Quarterly Ozone Line Loss using the following formulae:

NOTE: Before calculating "Quarterly Ozone Line Loss", subtract zero response at each test level.

$$\text{Ozone line loss \% for each level} = \frac{\text{Outside Line Total} - \text{Inside Line Total}}{\text{Inside Line Total}}$$

$$\text{Uncorrected Line Loss} = \frac{\text{Test Level 1} + \text{Test Level 2} + \text{Test Level 3}}{3}$$

$$\text{Corrected Line Loss \%} = \frac{\text{Previous Quarter Loss} + \text{Current Quarter Loss}}{2}$$

WARNING: If the current quarter line loss exceeds the previous quarter line loss by more than 1.5%, repeat the ozone line loss test.

17. Disconnect the "Outside" line from the front manifold and reconnect the "Inside" line.

18. Remove the ozone line loss test equipment from the "Line". Reconnect the 2' Teflon line, cap it, and wind it back on the hose reel. Place the end of the "Line" in the hose cradle, and lock the hose reel in place.

E.1.5.3 INSTRUMENT AND GAS RECERTIFICATION

1. API 400a Ozone Analyzer – The Standards Laboratory recertifies the UV Photometer against a Primary Photometer quarterly. The slope and intercept derived from the recertification are used in the calculation of audit van "True" ozone values.

2. Compressed Gases – The High CO (40 ppm), Low CO (7 ppm), and Superblend Cylinders are recertified semi-annually. The certified gas concentrations are used to determine the audit van "True" gas values

E.1.5.4 QUARTERLY AUDIT GAS COMPARISONS WITH STANDARDS LABORATORY

At the beginning of each quarter, an in-house crosscheck is performed with the Program Evaluations and Standards Section. The purpose of this crosscheck is to verify the actual concentrations of the diluted gases at the end of the audit van's "Line". This crosscheck is conducted using the same procedures outlined in this document. The results obtained from this crosscheck may be used to correct the computer generated audit gas concentrations to "Actual" audit gas concentrations in the event that a difference greater than ± 3.5% is determined.

E.1.5.5 ANNUAL RECERTIFICATION PROCEDURES

1. Annual recertifications are performed on the TECO 48c Carbon Monoxide analyzer and the barometric pressure transducer.

2. TECO 48c – Linearity is certified annually by the Standards Laboratory against NIST traceable primary CO standards for the 0-50 ppm range.

3. Barometric pressure transducer – Recertified annually by the Temperature Standards Laboratory in Arcadia, California. This is done by direct comparison with an NIST certified mercury manometer and a Wallace & Tiernan pressure gauge. The slope and intercept derived from this recertification are used to correct van values for "True" ozone and "True" flow.

OZONE LINE LOSS TEST FORM

Instrument: _____ ID#: _____ Date: _____

Quarter: 1[ ] 2[ ] 3[ ] 4[ ] Van A[ ] Van B[ ]

Previous Quarter Line Loss = [ ]

Test Point	Inside Line	Outside Line
Pre-Zero		
0.400		
0.175		
0.070		
Post-Zero		

Average % Difference = [ ]

Ozone Loss % Each Level = $\frac{\text{Outside Line Ozone Response – Inside Line Ozone Response}}{\text{Inside Line Ozone Response x 100}}$

Average % Difference = $\frac{\text{High Point + Middle Point + Low Point – (Pre-Zero + Post-Zero/2)}}{3}$

Quarterly Line Lose = $\frac{\text{Current Quarter Line Loss = Previous Quarter Line Loss}}{2}$

Quarterly Line Loss % = [ ]

Figure E.1.5.1
Ozone Line Loss Test Form